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Hydrology and Earth System Sciences Discussions

Interactive comment on "Geostatistical modeling of spatial variability of water retention curves" *by* H. Saito et al.

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The title of the manuscript has been modified to ''Alternative spatial interpolation method for water retention parameters" following the comments by Dr. T. Harter and Dr. M. Ye.

We agree with Dr. Ye that, the terminologies ''parametric" and ''non-parametric" may be misleading to those with statistical background. In this revised manuscript, we have decided to use ''Interpolate-first and fit-later or IF method" and ''Fit-first and interpolate-later or FI method" instead of ''parametric" and ''non-parametric" so that there will be no confusion even among those who have very strong statistical background.

As for second-order stationaritiy, it is the property of the model used but not the prop-

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Interactive Discussion

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erty of the data. There is no way to check rigorously whether or not the site satisfies the conditions required for second-order stationarity because we do not have complete information regarding the population but only have incomplete information from samples. We estimated local trends of h_b and lambda_b using ordinary kriging (Figures not shown here). These trends are as expected not constant. But there is not clear layering observed either. In this sense, we can say that we decided to use the second-order stationary model and that should not be a problem.

We have conducted the P approach (it is called the FI approach in the revised manuscript) with indicator kriging (IK). IK was used for estimating model parameters other than saturated and residual water contents for all three models. In IK, conditional cumulative distribution functions are constructed and corresponding E-type estimates are obtained at all sampling locations. Nine thresholds correspond to nine deciles of the distribution were used. Since full IK was considered, nine semivariograms needed to be modeled for each parameter. As a result, for each retention curve model, twenty semivariograms have to be modeled that is much more demanding than the IF approach. Estimation errors were then computed as done for other approach. New figures in the revised manuscript show MAE and MSE for IF and FI approaches with those obtained using IK. Overall, IK is more demanding than any other approach in terms of semivariogram modeling and results in largest errors. As pointed out by Dr. Romano in his comments, dealing with retention parameters may result in bias. Our result indicates that whether OK or IK is used, prediction performance does not improve in the FI approach.

As for the magnitude of errors, if these errors are obtained after fitting retention curves to retention data, they are too big to be acceptable. However, in this manuscript, model parameters were obtained not by fitting directly to retention data but obtained indirectly from different interpolation approaches. Errors may look too big but, based upon the purpose of this study, comparing different approaches is more important than discussing absolute values of those errors. In this sense, it is important to know that the

HESSD

5, S2610–S2612, 2009

NP (or IF) results in smaller errors than the P (FI) approach.

Dr. Ye is absolutely right that there are different types of uncertainty associated with parameter estimation. This was also questioned by Dr. Harter that we did not take any uncertainty into account. In the revised manuscript, we account for estimation error (also known as kriging variance) in the fitting procedure (see details in the revised manuscript) in the IF approach. The overall results did not change as kriging variance does not change much spatially because of the highly dense data set. Considering uncertainty more is beyond the scope of this study. We would like to do it in the next work to analyze how these uncertainties introduced in many different steps propagate through interpolation procedure.

We also think that if there are secondary variables available to improve the estimation of retention parameters cokriging should work better than ordinary kriging or other kriging that considers only one variable. As for the Las Cruses data set, however, there are no measured water content data that can be used in cokriging as a secondary variable. What we can do in future may be to map water contents at a given pressure head and to take such a map into account in (collocated) cokriging as a secondary variable.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 2491, 2008.